Key ideas -- Earth's Place in Space (Astronomy)

Earth Motions

Geocentric: Earth centered theory, everything revolves around the Earth. (proven incorrect).

Heliocentric: the Sun is the center of our solar system and the planets revolve around it.

The Earth **rotates** from west to east. It takes one day (24 hours) to make one complete **rotation.**

Evidence for the Earth's rotation include the **Coriolis Effect** and the predictable motions of **Foucault's Pendulum**.

The Earth **revolves** counterclockwise in one year (365.25 days) to complete one **revolution** or **orbit** around the Sun.

Evidence for the Earth's revolution include: different **constellations** are visible at different times of the year; seasonal changes; and the cyclically-changing **apparent diameter** of the Sun.

The Sun appears overhead (at the **zenith**) between the **Tropic of Cancer (23-1/2 degrees N latitude)** and the T**ropic of Capricorn (23-1/2 degrees S latitude).**

The Sun is beneath the Tropic of Cancer at the **Summer Solstice** (around June 21), and beneath the Tropic of Capricorn at the **Winter Solstice** (around December 21.)

The Sun crosses the Equator at the **Spring/Vernal Equinox** (around Mar 21) and **Fall/Autumnal Equinox** (Sep 21.)

At **Perihelion**, in early January during our winter, the Earth is closest to the Sun.

At **Aphelion**, in early July during our summer, the Earth is farthest from the Sun.

The Sun never reaches the **zenith** (center of the sky) in New York State. (There is always a shadow)

The lower the height (**altitude**) of the Sun the longer the shadow of an object will be.

The shadow of an object will be longest at sunrise and sunset, and shortest at **solar** or **local noon** Shadows appear to move from west to north to east. (This is why clock hands turn in that direction.

Planetary and satellite orbits

The orbits of all the planets are **ellipses** (oval shaped).

Planets, moons, and satellites are held in orbit around their "primary" object, such as the Sun, through a balance between **gravity** and **inertia**.

Gravity will be greater for objects that are bigger (have more mass) and closer together.

Gravity acts to pull two object together. This explains why everything falls down toward the ground unless support. If gravity were to stop, all the planets and the Moon would be flung into space.

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Inertia is the tendency of moving objects to remain moving in a straight path, unless acted on by an external force.

The elliptical shape of Earth's orbit around the Sun, Moon's orbit around Earth, and an artificial satellite around our planet can be explained as the result of a balance between gravity's tendency to pull the object together and inertia's role in keeping them moving in straight paths.

The **eccentricity** of an **ellipse** is found by dividing the distance between the **foci** (focal length) by the length of the **major axis**. A perfect circle has an eccentricity of "0.0". The more **elliptical** the orbit, the closer the eccentricity gets to "1.0."

A planet travels faster when it is closer to the Sun, slower when farther away from the Sun. Earth's **orbital velocity** is greatest near Perihelion and slowest near Aphelion.

Earth-Moon relationships

The Moon is Earth's only natural **satellite**.

The first artificial satellite, Sputnik, was launched in 1957 by the USSR. Today, there are thousands of man-made objects orbiting our planet. Some of the most familiar are weather satellites, which give us images of hurricanes and other storms.

Current theories explain the Moon's origin as the result of a collision between Earth and an asteroid or other object early in Earth's history.

The dark parts of the Moon are huge basaltic lava flows, and the light areas are mountains made of rocks similar to those in the Adirondack Mts.

Although half of the Moon is always lighted by the Sun, as the Moon orbits Earth we generally see only part of the lighted side. This explains the **phases of the Moon.**

It takes about 29-1.2 days to complete one cycle of phases from **New Moon** through **New (Waxing) Crescent, First Quarter, New (Waxing) Gibbous, Full Moon, Old (Waning) Gibbous, Last or Third Quarter, Old (Waning) Crescent,** and back to New Moon.

The Moon revolves and rotates at exactly the same rate, so we always have the same side facing toward us. The "far side of the Moon" has only been seen by the Apollo astronauts during the 1960s and 70s.

Gravitational attraction from the Moon and other forces acting on the oceans create the daily change in heights known as **tides.**

Because the Moon moves part of the way in its orbit during the time it takes Earth to make one rotation, the time between high tide on one day and the high tide on the next day is approximately 24 hours 50 minutes.

The Moon has no atmosphere, so its surface is covered by thousands of **craters** from impacts of meteorites and asteroids.

The Solar System

The Sun ("Sol"), nine planets, their satellites, asteroids, and comets comprise the Solar System.

Mercury, Venus, Earth, and **Mars** are the **terrestrial planets**. They are small, rocky, and dense. Mars has two moons, but Mercury and Venus have none.

The **Jovian planets--Jupiter, Saturn, Uranus,** and **Neptune--**are large, gaseous, and of low density. They have many satellites and rings.

Pluto lies beyond Neptune, but because it is so far away little is known about it. It has one satellite.

Deep Space

Astronomers constantly seek additional information about our solar system and beyond using a variety of **telescopes**. Some capture light radiated or reflected from **celestial bodies**, while others use different wavelength, such as X-rays.

Our Sun is located in one of the **spiral arms** of the **Milky Way Galaxy**, which contains more than 100 billion stars.

Stars evolve and change over time. The temperature and **luminosity** of a star vary throughout its lifetime.

Depending on its temperature and its mass, a star will follow a particular path of development, as depicted on the **"Temperature and Luminosity Chart"/"Hertzspring-Russell Diagram".**

The Sun is a **Main Sequence** star. It formed out of a gaseous **nebula** about 4.6 billion years ago, when temperatures became hot enough so that **hydrogen** was transformed in **helium** through **nuclear fusion**. The Sun is thought to be about halfway through its life cycle.

Stars seem to go from the Main Sequence into the **Red Giant** stage. During this stage, heavier elements form, including carbon, nitrogen, oxygen, silicon, and iron. Eventually, they explode in a **nova** or **supernova.** During this explosion, atoms of the heaviest elements, up to Uranium, are created and sprayed into space. These atoms may be gathered in new nebula gas and dust clouds, and begin the process again.

Stars that are much larger and much hotter than the Sun have a much shorter lifetime. Smaller and cooler stars apparently have much longer lifespans.

The Milky Way is one of about fifteen galaxies forming the **Local Cluster**, but only one of billions of galaxies scattered around the **Universe.**

The Universe is though to be about 13 billion years old.

The **Big Bang Theory** of the origin of the universe is favored by most astronomers, and supported by such evidence as the **microwave background radiation** and the **red shift** of distant objects seen from Earth.